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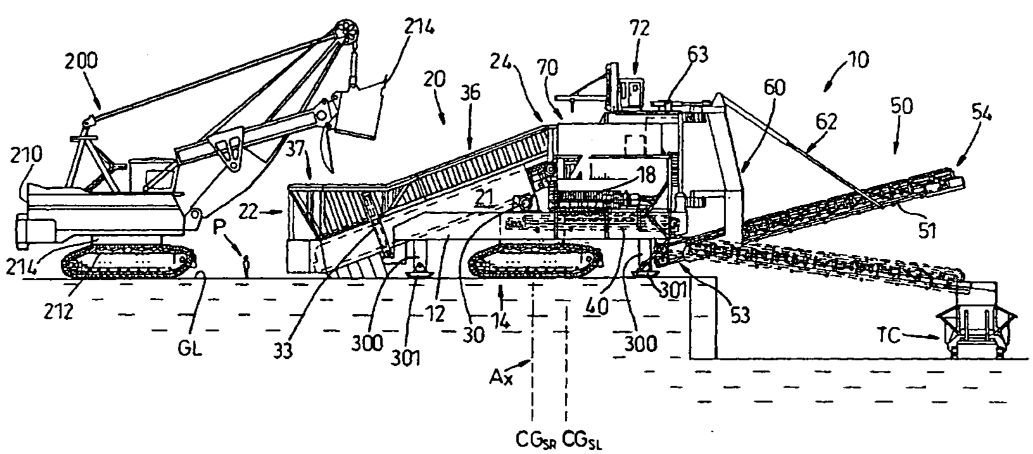
(54) **Title:** FULLY MOBILE RIG



(57) **Abstract:** A mobile mineral breaking station including a chassis (12) rotatably mounted on a ground engaging carriage (14) for rotation about a vertical axis, selectively operable drive means for controlling rotation of the chassis about said vertical axis, a mineral breaker (18) mounted on the chassis (20), a mineral feed boom mounted on and projecting from the chassis, the feed boom having a mineral discharge end (24) located adjacent to the mineral breaker and a mineral intake end (22) remote from the chassis, a feed conveyor (26) for moving mineral from the mineral intake end to the mineral discharge end of the feed boom, the mineral feed boom being movably mounted on the chassis so as to be movable between a low position whereat the mineral feed end of the boom rests upon the ground and a raised position whereat the mineral feed end of the boom is clear of the ground, a mineral discharge boom (51) mounted on and projecting from the chassis, the mineral discharge boom having a mineral intake end (53) located adjacent to the chassis and a mineral discharge end (54) remote from the chassis, and a takeaway conveyor (56) for moving mineral from the intake end to the discharge end of the takeaway conveyor.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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FULLY MOBILE RIG

The present invention relates to a mobile mineral breaking station and to a method of open cast mining.

In open cast mines it is known to provide mineral breaking stations which are fed with won mineral by a series large trucks. The trucks are filled with won mineral by on or more large tracked diggers located at the mine wall face. Once filled, the trucks drive to the mineral breaking station.

During mining by the digger(s), the mine wall face recedes from the mineral breaking station both horizontally (as the open cast mine becomes wider) and vertically (as the open cast mine becomes deeper). Accordingly, during mining the distance which the trucks have to travel progressively increases and so, in order to maintain a desired level of mineral output from the mine, more trucks are required as this distance increases.

These trucks are very expensive to purchase and maintain and so eventually, when the distance the trucks have to travel between the mine wall face and the mineral breaking station exceeds a predetermined distance, mining becomes uneconomical.

In such circumstances it is desirable to move the mineral breaking station closer to the mine wall face.

Typically a mineral breaking station is expected to handle several thousands of tons of mineral per hour and so they tend to be very large structures in order to be able to cope with this throughput.

Certain types of mineral breaking stations, generally known as static

stations, cannot be moved. Another type of breaking station, known as a semi-mobile breaking station, is intended to be moved infrequently, eg at intervals separated by several months.

Moving a semi-mobile breaking station tends to be a major operation since the station normally has to be dug out, then raised clear of the ground and then carried carefully and slowly on a supporting vehicle to its new location. Once at its new location ground ramps need to be constructed to enable the feeder trucks to drive to an elevated position for depositing mineral into the mineral breaking station. Accordingly, re-location of a semi-mobile station can take several days during which time no mineral output from the mine is possible.

It is therefore highly desirable to provide a mineral breaking station suitable for use in an open cast mine for handling large tonnage per hour and which is fully mobile.

This has major advantages in that it enables the breaking station to 'follow' the mine wall face and thereby receive won mineral directly from the digger(s). With such an arrangement the need for trucks is eliminated and downtime resulting from the relocation of a semi-mobile mineral station is substantially reduced or eliminated.

According to one aspect of the present invention there is provided a mobile mineral breaking station including a chassis rotatably mounted on a ground engaging carriage for rotation about a vertical axis, selectively operable drive means for controlling rotation of the chassis about said vertical axis, a mineral breaker mounted on the chassis, a mineral feed boom mounted on and projecting from the chassis, the feed boom having a mineral discharge end located adjacent to the mineral breaker and a mineral intake end remote

from the chassis, a feed conveyor for moving mineral from the mineral intake end to the mineral discharge end of the feed boom, the mineral feed boom being movably mounted on the chassis so as to be movable between a low position whereat the mineral feed end of the boom rests upon the ground and a raised position whereat the mineral feed end of the boom is clear of the ground, a mineral discharge boom mounted on and projecting from the chassis, the mineral discharge boom having a mineral intake end located adjacent to the chassis and a mineral discharge end remote from the chassis, and a takeaway conveyor for moving mineral from the intake end to the discharge end of the takeaway conveyor.

According to another aspect of the present invention there is provided a breaking station wherein the chassis is provided with a plurality of extendible ground engaging legs, the legs being controllably movable from a retracted position to an extended position, the legs in their retracted position being clear of the ground and in their extended position being engagable with the ground.

According to another aspect of the present invention there is provided a breaking station wherein the extendible legs are capable of raising the chassis away from the ground to lift the carriage clear of the ground.

Various aspects of the present invention are hereinafter described with reference to the accompanying drawings, in which:-

Figure 1 is a side view of a mobile breaking station according to an embodiment of the present invention shown in combination with a digger.

Figure 2 is an end view of the mobile breaking station shown in Figure 1.

Figure 3 is a plan view of the mobile breaking station and digger combination shown in Figure 1.

Figure 4 is a perspective view, from above, of the carriage of the breaker station shown in Figure 1.

Figure 5 is a plan view from above of the carriage shown in Figure 4.

Figure 6 is a perspective view, from below, of the carriage shown in Figure 4.

Figures 7 to 9 are schematic diagrams showing examples of the mobile breaking station and digger combination in use.

Referring initially to Figures 1 to 6 there is shown a mobile mineral breaking station 10 which includes a chassis 12 which is supported clear of ground level GL by a carriage 14.

The chassis 12 carries a mineral breaker 18 which is preferably a mineral breaker of the twin drum type as described, for example, in our European patent 0 167 178.

Mineral to be broken is fed to the mineral breaker 18 by a feed conveyor assembly 20. The feed conveyor assembly 20 is preferably in the form of a boom 21 having a mineral intake end 22 located remote from the chassis 12 and a mineral discharge end 24 which is located adjacent to the mineral breaker 18. A conveyor 26, referably in the form of a plate conveyor, is provided for moving mineral from the mineral intake end 22 to the discharge end 24 of the boom 21 for discharge into the mineral breaker 18.

The boom 21 is preferably defined by a hollow modular structure of the type describe in our PCT patent specification WO99/54049.

The boom 21 is movably mounted on the chassis 12, preferably by a journal 30, such that the boom 21 may be moved between a low position (as shown in Figure 1), whereat the intake end 22 of the boom 21 rests on the ground,

to a raised position (not shown) whereat the intake end 22 is clear of the ground.

Lifting means, preferably in the from of a pair of hydraulic rams 33 are provided for moving the boom 21 between its low and raised positions.

Preferably hopper walls 36 are provided which extend above the conveyor 26 to define a hopper 37 at the intake end 22 of the boom 21 as well as a retaining wall for retaining mineral on the conveyor 26 as it is conveyed to the discharge end 24.

A discharge conveyor 40 is mounted on the chassis 12 beneath the mineral breaker 18 and is arranged to convey mineral discharged from the breaker 18 to a takeaway conveyor assembly 50.

The takeaway conveyor assembly 50 is in the form of a boom 51 which is mounted on and projects from the chassis 12.

The boom 51 has an intake end 53 which is located adjacent to the chassis 12 in order to receive mineral from the discharge conveyor 40. The boom 51 also has a discharge end 54 which is located remotely from the chassis 12 to enable mineral to be discharged onto a takeaway conveyor TC for taking the mineral out of the mine.

A conveyor 56, preferably in the form of a belt conveyor, is mounted on the boom 51 to convey mineral from the intake end 53 to the discharge end 54 of the boom 51.

Preferably the boom 51 is movably mounted on the chassis 12 so as to be capable of moving the discharge end 54 both vertically and horizontally

relative to the chassis 12.

Preferably, in the horizontal plane, the boom 51 is movable up to 60° either side of the longitudinal axis of the station 10 and in the vertical plane is movable about 15° above the horizontal and about 7° below the horizontal.

Preferably this is achieved by pivotally mounting the boom 51 on a cradle 60 for movement about a horizontal axis relative to the cradle 60 and by mounting the cradle 60 onto the chassis 12 for movement about a vertical axis relative to the chassis 12.

Movement of the boom 51 relative to the cradle 60 is preferably controlled by a hydraulic ram 62 and movement of the cradle 60 relative to the chassis is preferably controlled by a pair of opposed hydraulic rams 63.

Also mounted on the chassis 12 is a housing 70 for enclosing an engine for powering the necessary electric and hydraulic systems for driving the conveyors, mineral breaker 18, etc. A control cabin 72 for housing operative personnel is preferably located above the housing 70.

The chassis 12 is carried, at least when the station 10 is moving across the ground, by the carriage 14.

The carriage 14 includes a pair of continuous track assemblies 110 which are mounted on a support platform 114. Each track assembly 110 is preferably independently driven by a motor 112; the motors may either be electric or hydraulic. A mounting platform 116 is rotatably mounted on the support platform 114 by a turntable bearing 118 for rotation about an axis Ax.

Internally of the turntable bearing 118 one of the platforms 114, 116 is provided with a ring gear (not shown) and the other is provided with a pinion geer which meshes with the ring gear. A controllable turntable drive motor (not shown) drives, when actuated, the pinion gear to cause relative rotation about axis Ax between platforms 114, 116.

Mounting platform 116 is secured to chassis 12 by upstanding plates 116a.

Accordingly, when the feed boom 21 is moved to its raised position it is possible by actuation of the turntable drive motor to cause the chassis 12 to rotate about axis Ax relative to the support platform 114 and the track assemblies 112 carried thereby.

Also, whilst the feed boom 21 is in its raised position, selective actuation of motors 112 causes the station 10 to advance and/or turn in response to an operatives' control.

Thus the station 10 may be conveniently moved from one location to another and when at a particular location it can be swung about axis Ax for more accurate positioning.

Once in a desired location, the boom 21 is moved to its low position to engage the ground in readiness for the hopper 37 to receive won mineral from a digger 200.

The digger 200 is of conventional construction having a main body 210 mounted on a carriage having a pair of track assemblies 212 via a turntable 214. The main body 210 carries a digging bucket 214 which is operated in a conventional manner.

Preferably the chassis 12 is provided with a plurality of extensible legs 300 having ground engaging feet 301. Each extensible leg 300 is extensible from a fully retracted position towards the ground to a fully extended position. The amount of extension of each leg 300 is such as to enable its foot 301 to be located at level beneath the lower level of the track assemblies 110.

Each leg 300 is preferably powered to move to its extensible position by a ram, preferably a hydraulic ram. Preferably each leg 300 is independently operable so that, at any one time, each leg 300 may be extended by different amounts.

Accordingly, when the station 10 is static and in its mineral breaking operational mode, it is possible to extend the legs 300 such that their feet 301 engage the ground.

By selective extension of each leg 300 it is possible to level the station 10 in the event that the track assemblies 110 are located on uneven ground.

In addition, by lowering the legs 300 to engage the ground, it is possible to relieve loads and stresses from the carriage 14. This is particularly advantageous as it reduces the risk of brinnelling of the turntable bearing and operating components within the track assemblies. Furthermore, it is possible, by continued extension of the legs 300, to lift the track assemblies 110 clear of the ground. This is particularly advantageous as it enables the carriage 14 to be rotated to any desired angular position about axis Ax whilst clear of the ground. After lowering of the carriage 14 (by retraction of the legs 300) it is possible to move the station 10 in a direction of 90° away from a hazardous condition such as for example a ground collapse.

Also, the ability of being able to raise the track assemblies 110 clear of the ground is advantageous as it enables the track assemblies 110 to be serviced and maintained to prevent premature seizure.

Also, during transport on the carriage 14, the legs 300 may be lowered to act as stabilisers.

The chassis 12 and the various components mounted thereon (eg. the mineral breaker 18, booms 21, 51 and housing 70) are preferably constructed such that the centre of gravity CGs of the station 10 is located on the longitudinal axis Lax (as seen in Figure 2).

It will be appreciated that the centre of gravity CGs of the station 10 shifts along the longitudinal axis Lax in dependence of whether the boom 21 is in its low position whereat it contacts the ground or its raised position whereat it is clear of the ground.

These positions are shown substantially as CG_{SL} when the boom 21 is at its low position and CG_{SR} when the boom 21 is at its raised position.

In the embodiment where extendible legs 300 are not provided, the carriage 14 is located along the longitudinal axis Lax such that its rotation axis Ax is located inbetween the centre of gravity positions CG_{SR} and CG_{SL} at a suitable location to minimise horizontal twisting loads applied by the weight of the station 10 upon the carriage 14 via the bearings of the turnable bearing 118 when the boom 21 is either in its low or raised positions. A further advantage of the embodiment provided with extendible legs 300 is that due to the fact that legs 300 accommodate the weight of the station 10 when the boom 21 is in its low position, it is possible to locate the carriage 14 such that its axis of rotation Ax is substantially co-axial with centre of

gravity position CG_{SR}. Thus during movement of the station 10 on carriage 14, weight loads applied to the carriage 14 are evenly distributed about the turnable bearing 118.

The fully mobile station 10 described above is intended to be used in open cast mining operations and to be capable of handling about 10,000 tons of mineral per hour. The station 10 is therefore a large structure (in excess of 14 metres high and 15 metres wide) and to give an idea of scale a person P of average height is shown in Figures 1 and 2.

The mobile ability of the mobile breaker station 10 of the present invention enables it to operate in combination with a digger 200 to mine mineral from an open cast mine in a new manner.

This is illustrated, by way of example, in Figures 7 to 9.

In Figure 7 to 9 a plan view of an open cast mine is shown having a bench 500 of mineral which is to be removed. The bench 500 has a mine wall face 501 from which won material is dug by the digger 200.

A conventional takeaway conveyor TC for conveying mineral discharged from the breaker station 10 is provided. Typically, as shown, takeaway conveyor TC extends in a generally straight line out of the mine.

Preferably, a roadway conveyor Rc extends at 90° from the takeaway conveyor TC along a roadway Rw at one side of the bench 500.

Initially, the station 10 is shown with boom 51 arranged to deposit mineral onto the conveyor Rc. The digger 200 operates to dig away the bench 500 to create a first passing zone P_z (shown in solid lines).

The depth D of the passing zone is preferably equivalent to two bands T_1 and T_2; each band being a width of the bench 500 which the digger 200 is able to remove by operating its bucket whilst slewing about its carriage.

Once the first passing zone P_z has been created by the digger digging around station 10, the digger 200 may be driven to a position whereat its track assemblies 212 are substantially parallel to the takeaway conveyor Tc. Similarly the mobile station 10 can be moved to a position adjacent to the digger 200 with its boom 51 repositioned to discharge mineral onto the conveyor Tc. The track assemblies 110 of the station 10 can also arrange to be substantially parallel to the takeaway conveyor Tc.

As seen in Figure 8, the station 10 is positioned with its hopper 37 adjacent to the digger such that, preferably, the digger 200 is able to slew in an arc in order to dig out a curved face C_f and deposit dug mineral directly into the hopper. Once the digger has completed digging away an arc of material to complete curved face C_f it advances on it track assemblies to be closer to the curved wall face C_f so as to be capable of removing a further arc of mineral. In this way the digger intermittently advances along the bench 500 and removes the first band T_1 of mineral. Each time the digger 200 advances to its new intermittent position, the station 10 is likewise advanced by raising the boom 21, moving the station 10 on carriage 14 to its new position and then lowering boom 21 into contact with the ground. Since both the track assemblies of the digger 200 and station 10 are substantially parallel to the conveyor Tc, minimal steerage of either the digger 200 or station 10 is required when advancing to its new position.

At the end of the first pass (ie removal of hand T_1) the digger 200 is advanced toward the bench 500 so as to be able to remove the next band T_2

of mineral. The digger 200 has therefore now moved further away from the takeaway conveyor Tc. In order to compensate for this displacement of the digger away from the takeaway conveyor Tc, it is necessary to reposition the station 10 so that the hopper 37 carried by boom 21 is located further away from the takeaway conveyor Tc whilst maintaining track assemblies 110 substantially parallel to the takeaway conveyor Tc. This may be achieved by a combination of varying the angle of boom 51 relative to chassis 12 and/or slewing the chassis 12 relative to the carriage 14. When the station 10 has been repositioned, it is again able to follow progress of the digger 200 as it makes its next pass to remove band T_2.

After removal of the second band T_2, a further passing zone P_z is dug (shown in broken lines in Figures 7 and 8) of a depth equivalent to bands T_3 and T_4 and the process is repeated to remove bands T_3, T_4.

Figure 9 graphically illustrates the final pass of the digger 200 when removing band T_4. It will be noted that to enable the last pass to be made, station 10 has been positioned boom 21 is located at 90° to the direction of travel of track assemblies 110 such that its hopper is located at a maximum distance from the takeaway conveyor Tc.

Once the final pass has been made, it is necessary to re-position the takeaway conveyor Tc closer to the bench 500 and repeat the process starting with the arrangement illustrated in Figure 7.

CLAIMS

1. A mobile mineral breaking station including a chassis rotatably mounted on a ground engaging carriage for rotation about a vertical axis, selectively operable drive means for controlling rotation of the chassis about said vertical axis, a mineral breaker mounted on the chassis, a mineral feed boom mounted on and projecting from the chassis, the feed boom having a mineral discharge end located adjacent to the mineral breaker and a mineral intake end remote from the chassis, a feed conveyor for moving mineral from the mineral intake end to the mineral discharge end of the feed boom, the mineral feed boom being movably mounted on the chassis so as to be movable between a low position whereat the mineral feed end of the boom rests upon the ground and a raised position whereat the mineral feed end of the boom is clear of the ground, a mineral discharge boom mounted on and projecting from the chassis, the mineral discharge boom having a mineral intake end located adjacent to the chassis and a mineral discharge end remote from the chassis, and a takeaway conveyor for moving mineral from the intake end to the discharge end of the takeaway conveyor.

2. A breaking station according to Claim 1 wherein the chassis is provided with a plurality of extendible ground engaging legs, the legs being controllably movable from a retracted position to an extended position, the legs in their retracted position being clear of the ground and in their extended position being engagable with the ground.

3. A breaking station according to Claim 2 wherein the extendible legs are capable of raising the chassis away from the ground to lift the carriage clear of the ground.

4. In combination, a mobile digger arranged to move along an open cast

mine wall face whilst removing mineral therefrom and a mobile mineral breaking station according to any of Claims 1 to 3 arranged to follow the digger along said mine wall face to receive mineral directly from said digger as it moves along said cast mine wall face.

5. A method of open cast mining, the method including mining mineral from an open cast mine wall face using a mobile digger which moves along said mine wall face and removes mineral therefrom as it does so, locating a mobile mineral breaking station according to any of Claims 1 to 3 adjacent to said mine wall face and moving said breaking station along said mine wall face so as to follow said digger and depositing won mineral directly from the digger into said mobile mineral breaking station.

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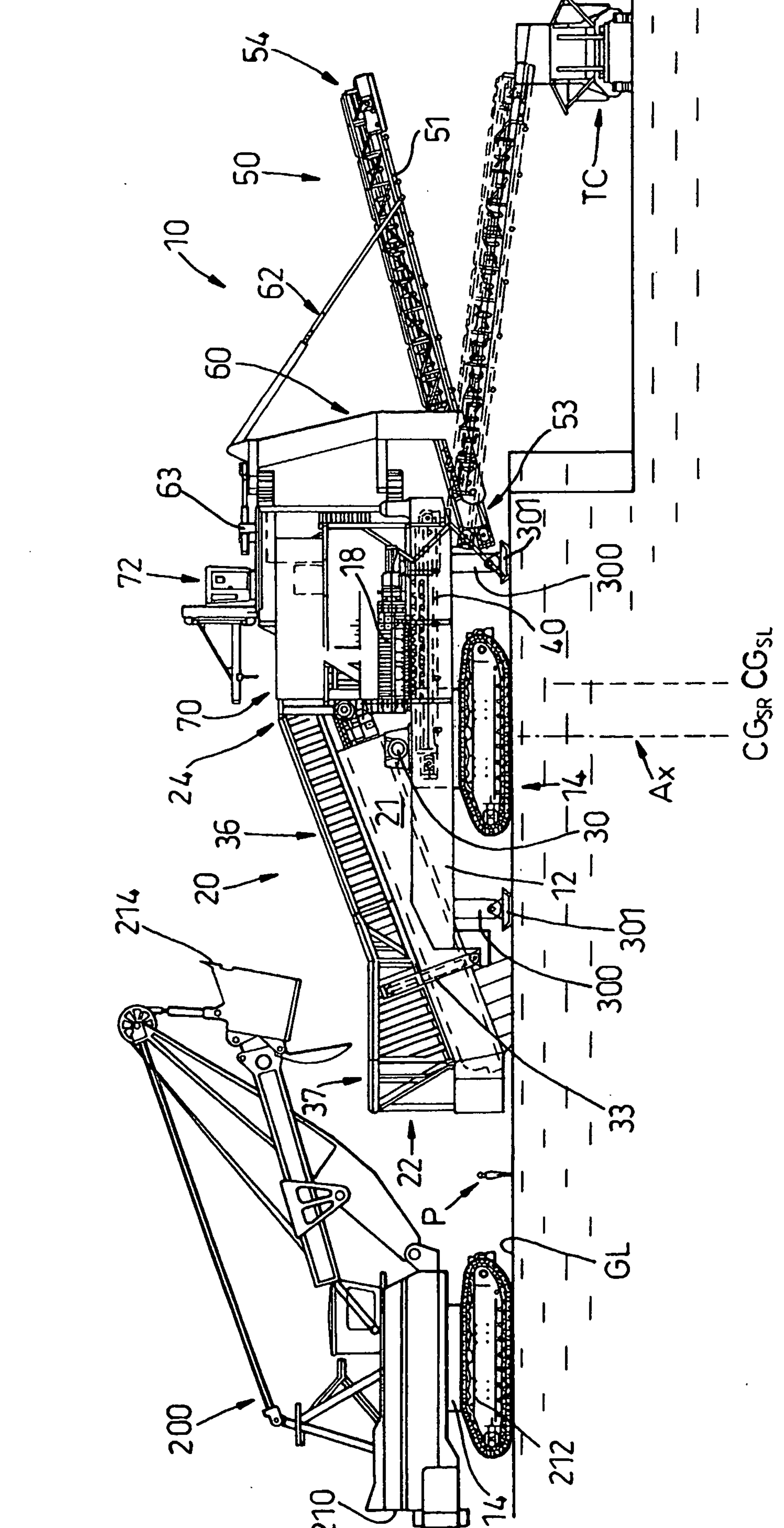
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TC
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CG_{SR} CG_{SL}

Fig. 1

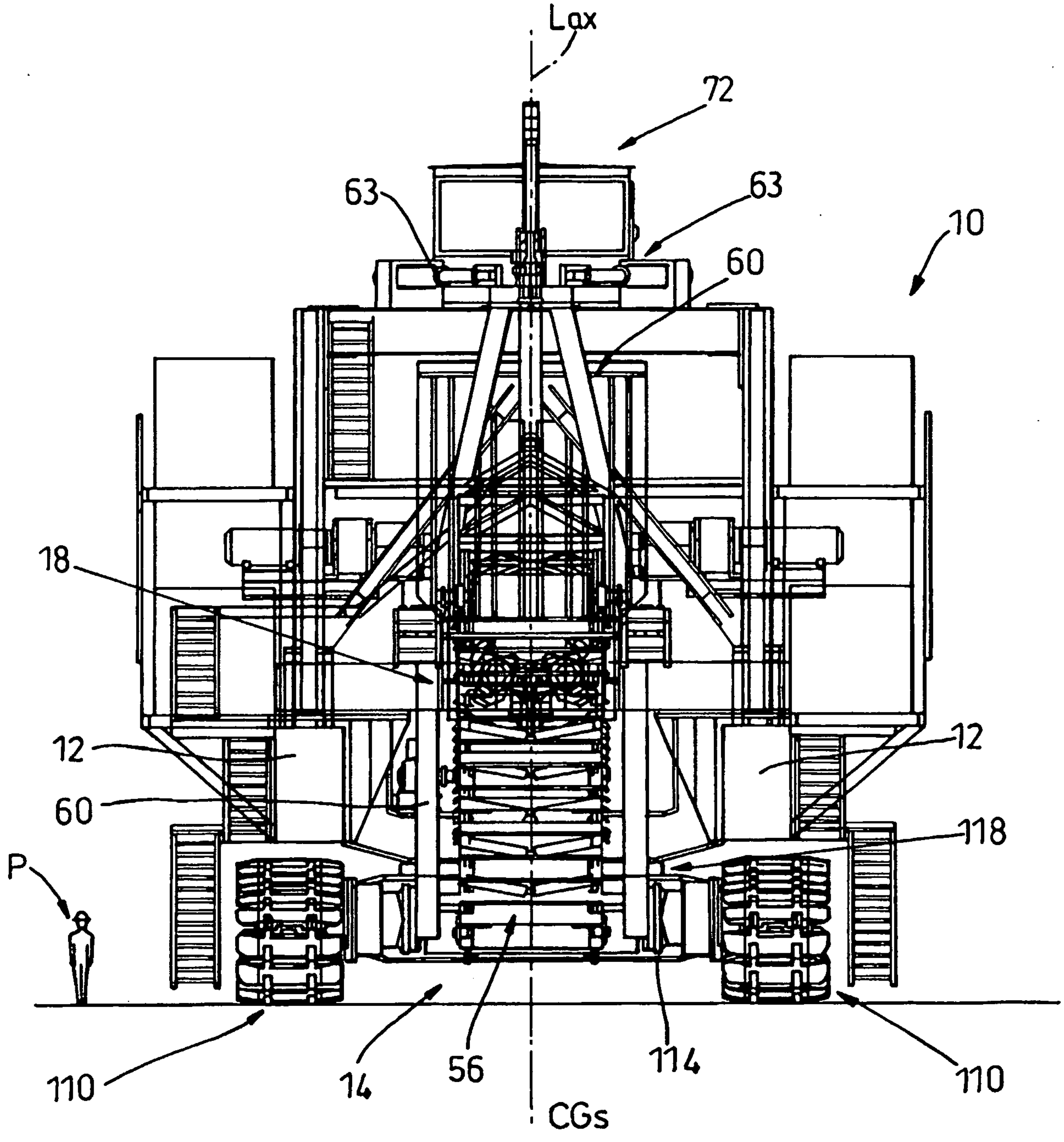


Fig. 2

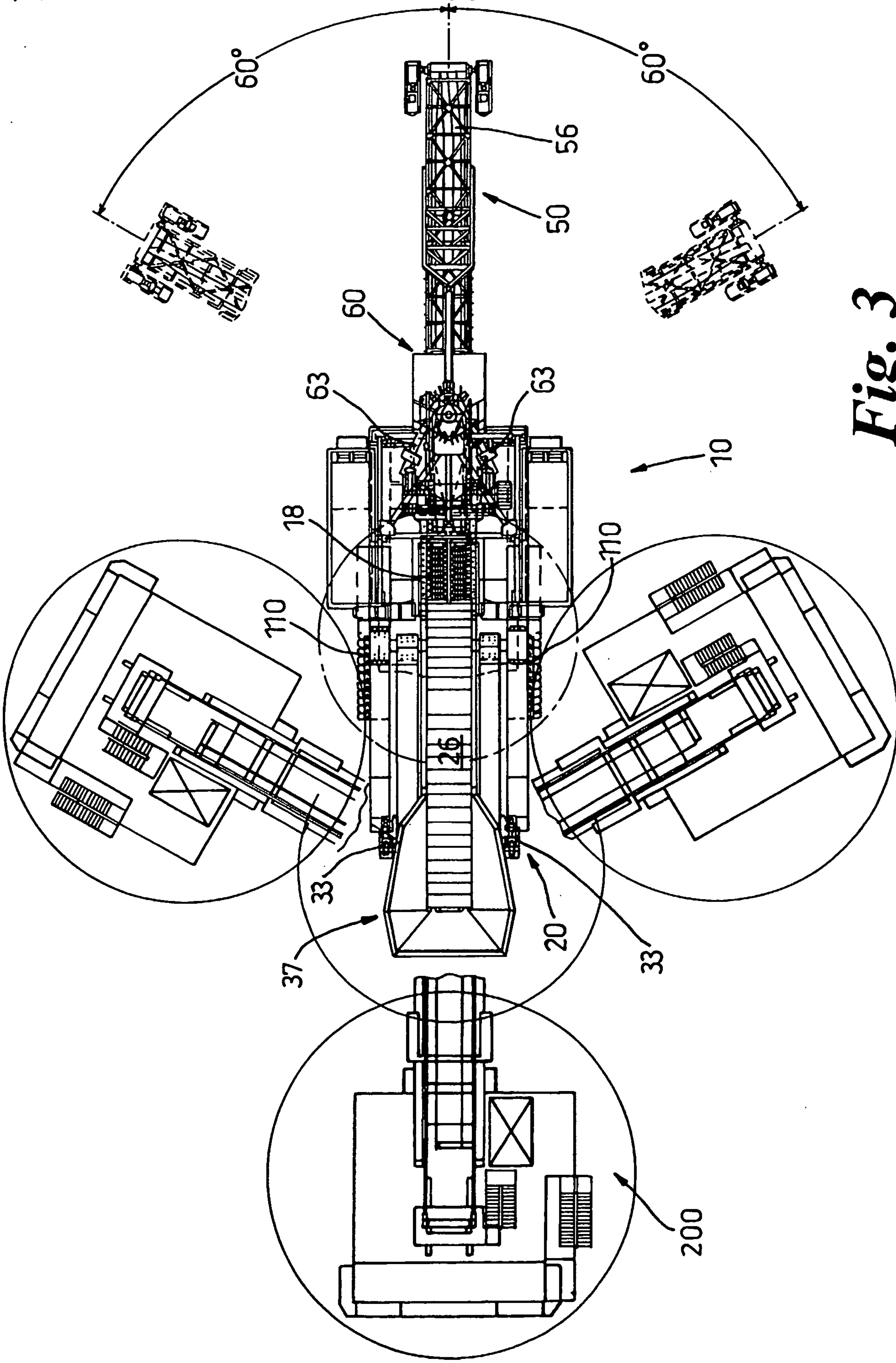
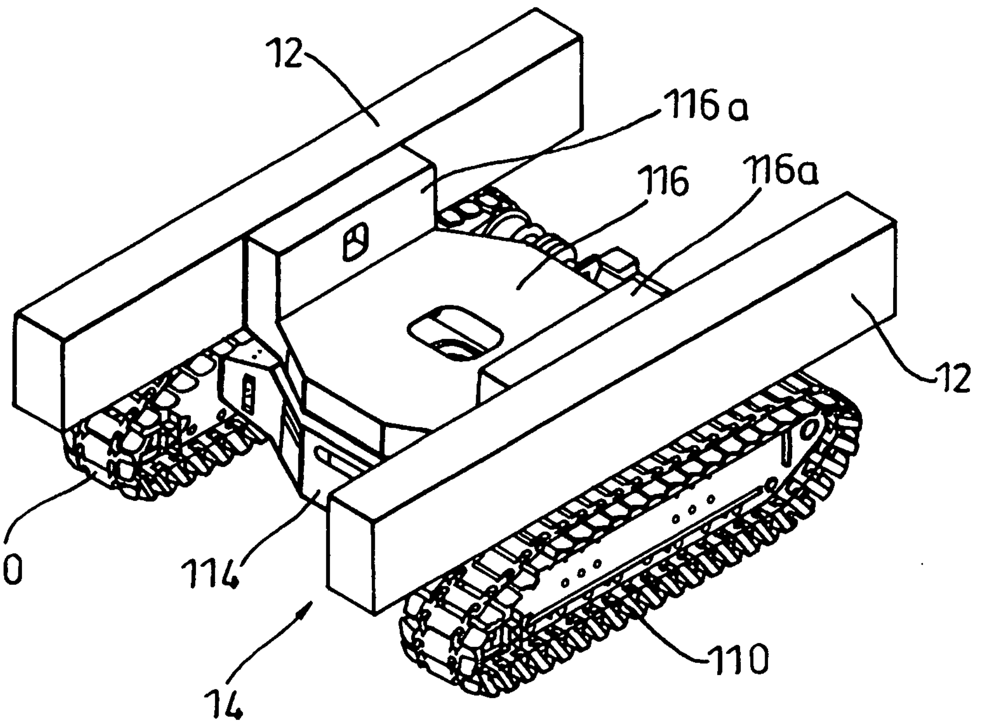


Fig. 3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116
116a
12
110
114
14
110

Fig. 4

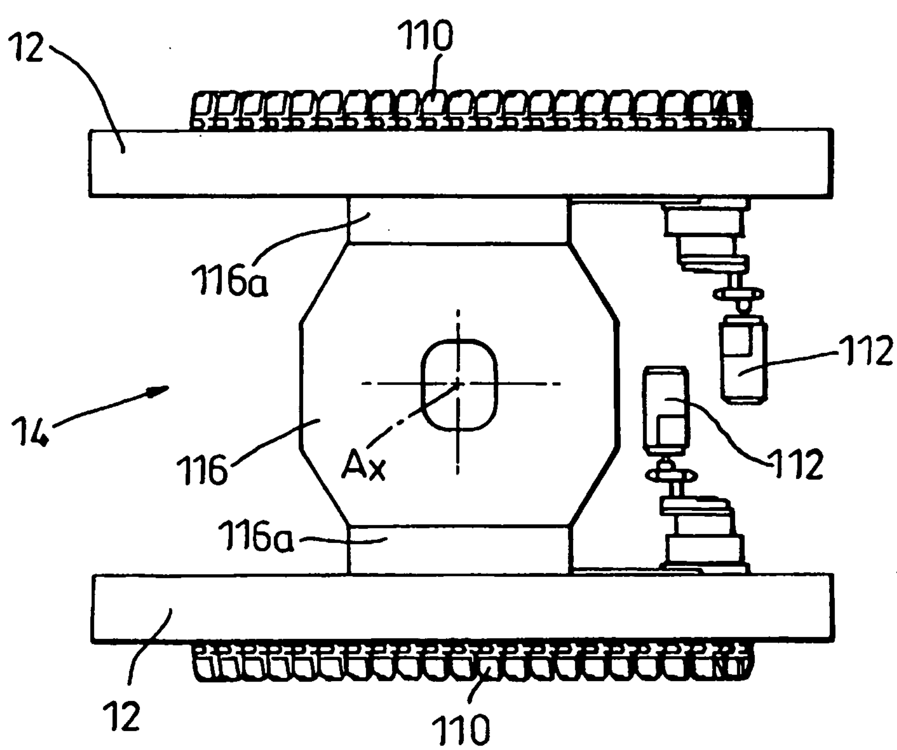
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Fig. 5

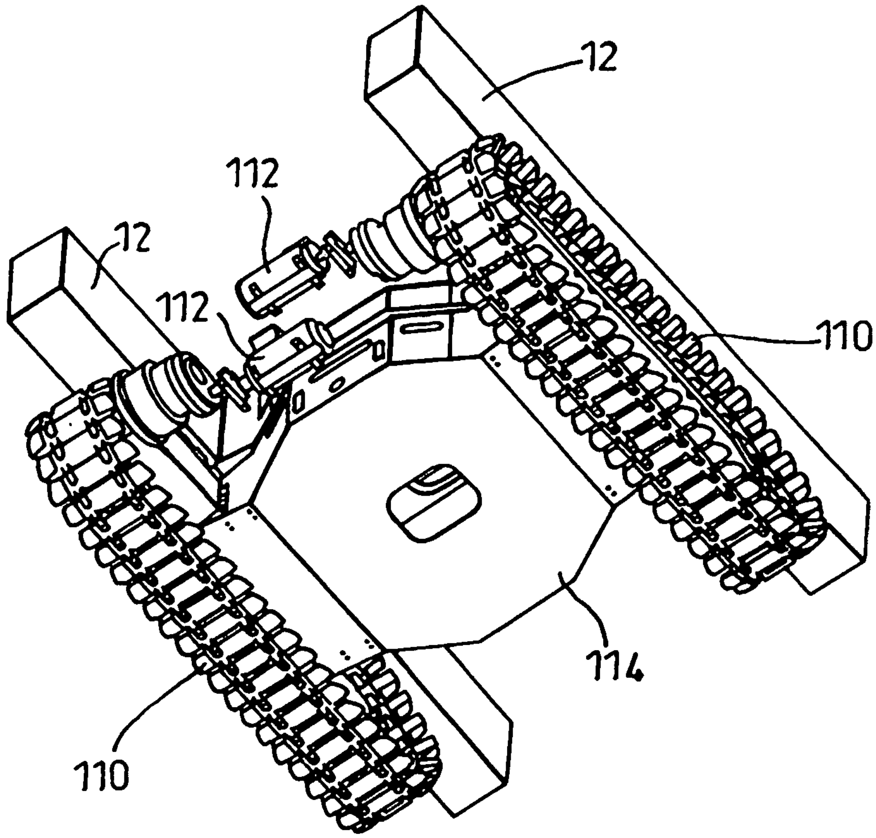

Fig. 6

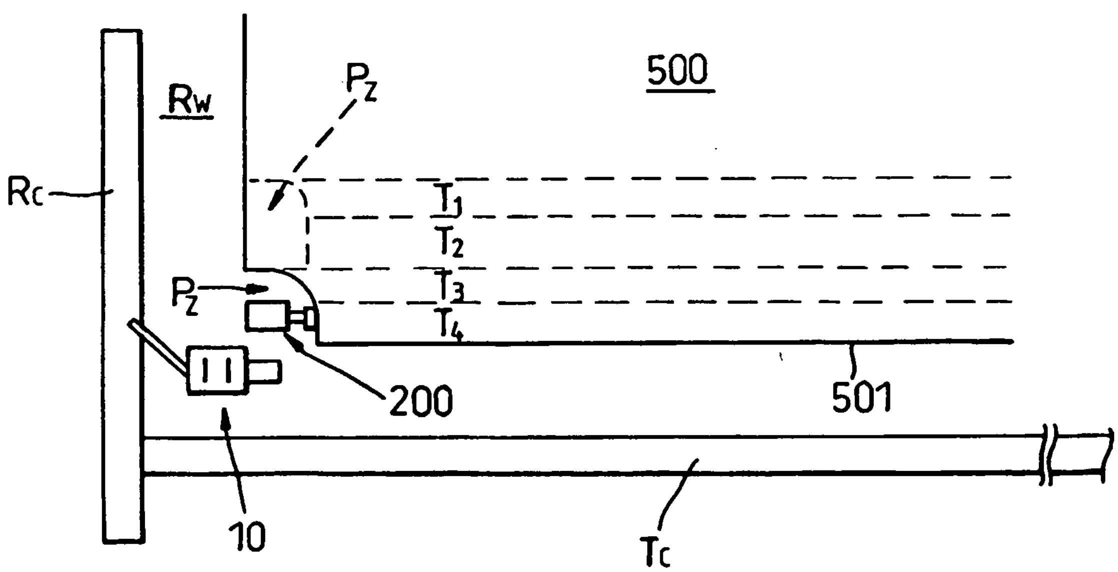

Fig. 7

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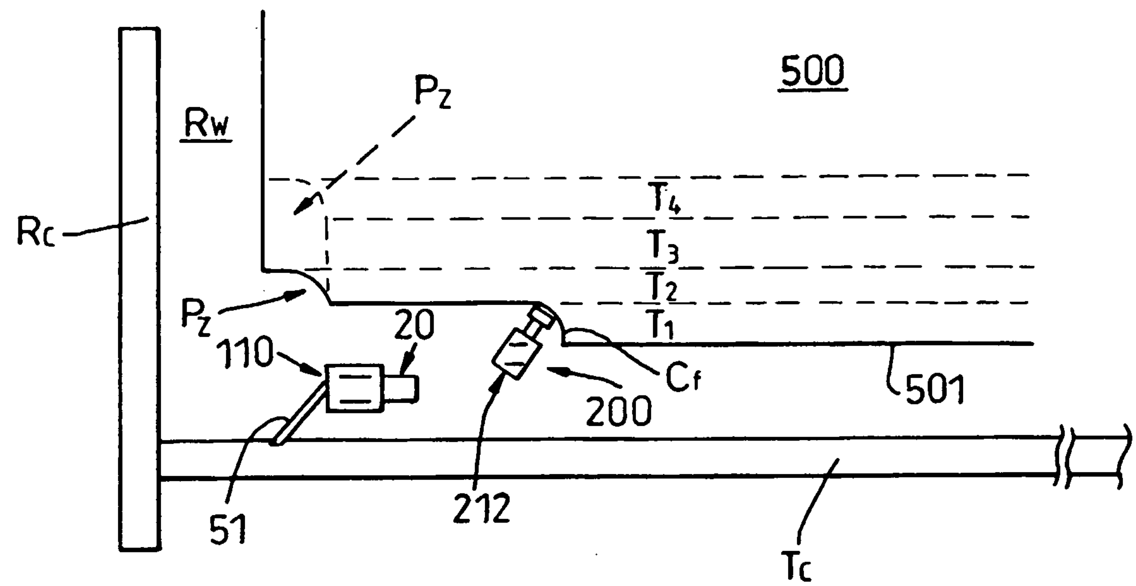
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Rw
Pz
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T3
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T1
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51
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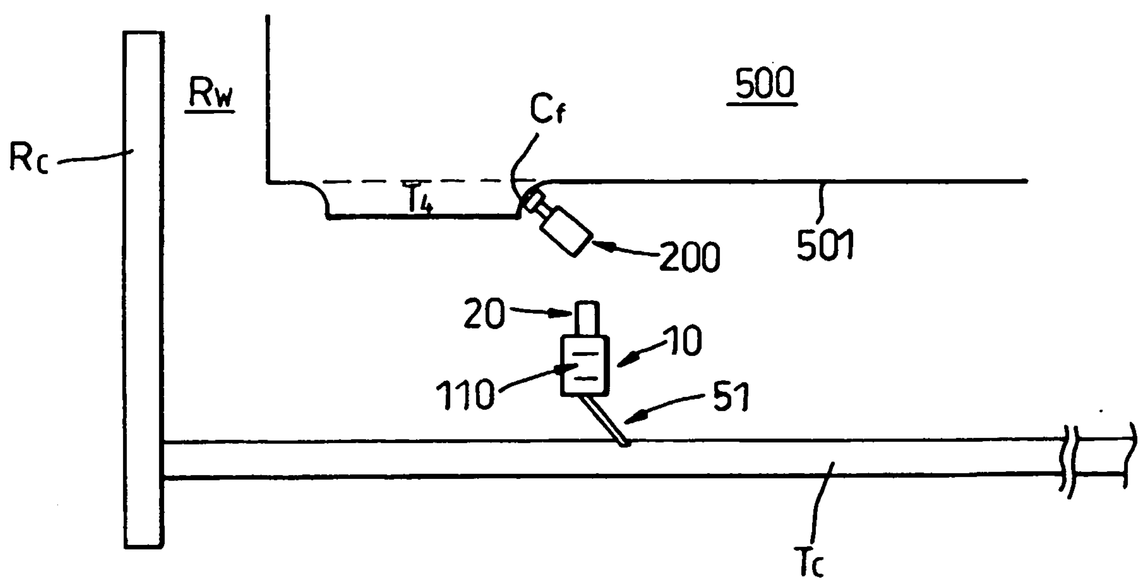
Tc

Fig. 8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T4
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Fig. 9

PCT/GB 02/02198

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B02C21/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B03B B02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	page 2 -page 5; claims 1,2	3
Y	US 5 161 744 A (MAURER HORST ET AL) 10 November 1992 (1992-11-10)	3
A	column 1, line 49 -column 2, line 13; figures 1-3	1,2
A	DE 39 36 681 A (WESER ENGINEERING GMBH) 31 May 1990 (1990-05-31) column 5, line 32 -column 7, line 25; figures 1-4	1,4,5

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
9 October 2002	21/10/2002

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